Technical Report No. 32-709

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N65 17874
(ACCESSION NUMBER)
(THRU) 1
9
(PAGES)
(CODE)
CR 60947
(NASA CR OR TMX OR AD NUMBER)
11
(CATEGORY)
FACILITY FORM 602

GPO PRICE $
OTS PRICE(S) $
Hard copy (HC) 1.00
Microfiche (MF) .50

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

January 15, 1965

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Prepared Under Contract No. NAS 7-100
National Aeronautics & Space Administration

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ABSTRACT

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In the vibration testing of spacecraft instruments, the effect of stray magnetic fields from the vibration exciter was found to produce undesirable residual magnetism in the instrument under test. This Report presents a simple and inexpensive method for the practical elimination of such stray magnetic fields.

Author

I. INTRODUCTION

All spacecraft and their components are subject to type-approval and flight-acceptance vibration tests in accordance with designated specifications. Proper operation of spacecraft instruments (such as the *Mariner-C* magnetometer and ion chamber) requires a maximum residual magnetic field of 5γ, measured at a distance of 3 ft from the components. This criterion was impossible to achieve after the components had been exposed to the magnetic environment of any of the Laboratory's operating electromagnetic vibration exciters, due to stray dc magnetic fields produced by the exciters. The exciter fields are shown in Fig. 1, which is a cut-away view of a

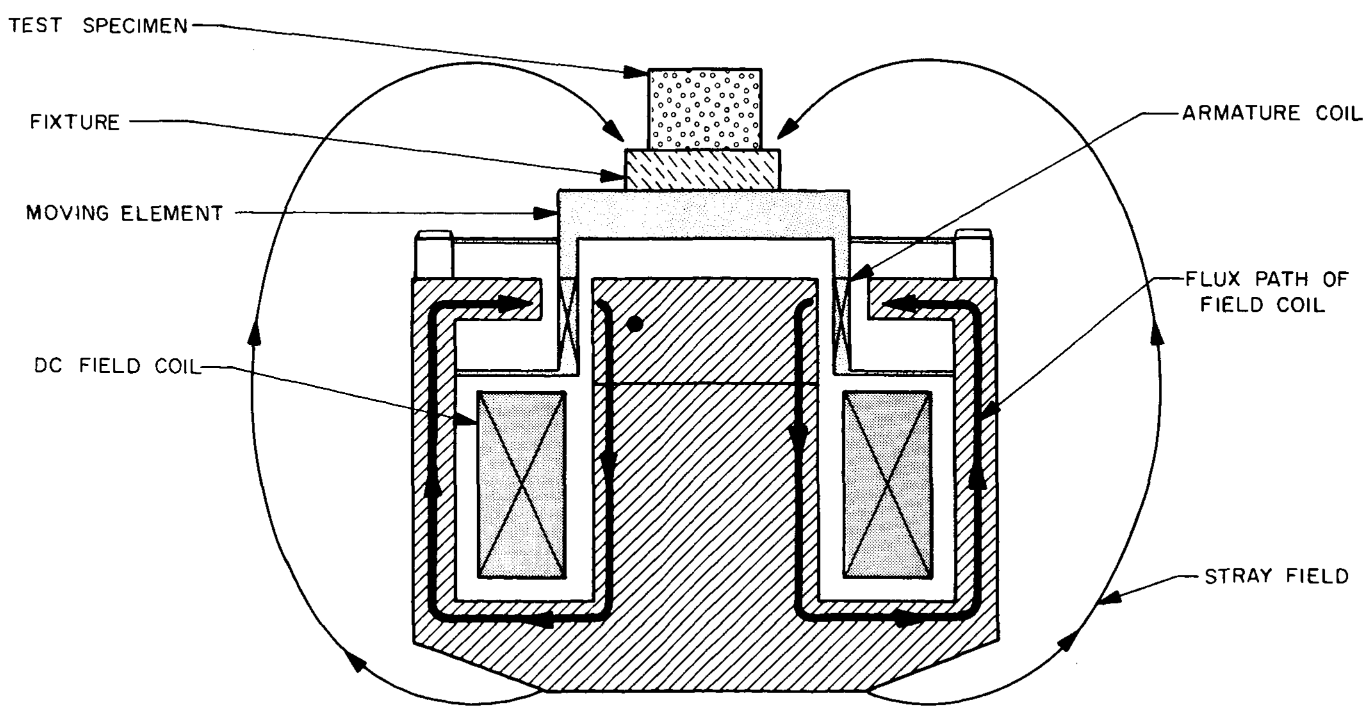

Fig. 1. Simplified cross-section of a typical gap-end exciter showing stray magnetic fields

typical gap-end vibration exciter.[1] The heavy arrows indicate the magnetic fields required for operation of the equipment; the light arrows indicate the stray magnetic fields, which contaminate the component under test. Figure 2 shows a vibration exciter in horizontal position. A piece of cardboard with iron filings was placed at the top end of the exciter, and the pattern of the stray magnetic fields is easily visible.

[1] Examples of gap-end vibration exciters are: Ling-Tempco-Vought Model Nos. B-44, B-48, and B-177; and MB (Mettler Bros.) Model Nos. C-10, C-25, and C-70.

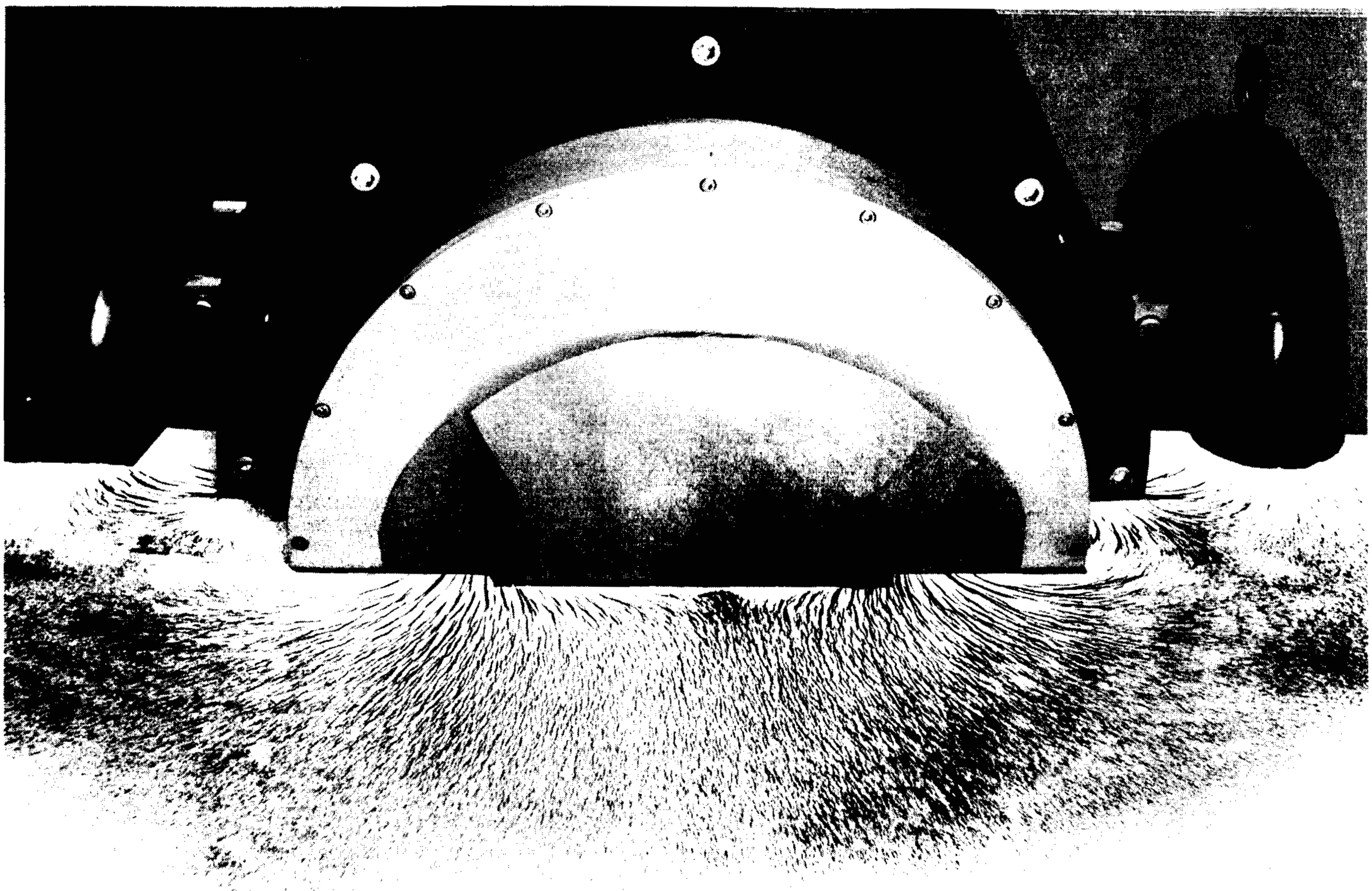

Fig. 2. Iron-filing demonstration of stray magnetic fields

II. THE MAGNETIC SHIELD APPROACH

One way to solve the entire problem was to install an exciter of new double-ended design in the environmental laboratory. However, the cost of the new equipment, plus the time required for delivery, installation, and testing, made this approach unacceptable. For these reasons, the author investigated the possibility of containing the stray magnetic fields by use of a shield.

Several isolated instances were found where the stray fields had been minimized by enclosing the entire vibration exciter in a box-like structure. There were several disadvantages to this approach: the structure was cumbersome; it required the use of an external exciter cooling system, an overhead hoist, and provisions for access to the unit under test; construction and installation of the device was time-consuming; the use of safety interlocks was required; testing and monitoring called for technically acute personnel; and the device was relatively expensive.

A much simpler shielding device was developed and proved to be entirely successful. It was completed in approximately 1 month, at one-fortieth the cost of a new exciter system.[2] The device provides a bypass path and/or a parallel magnetic diversion for the magnetic fields of the vibration exciter, at a safe distance from the component under test. The MB Model C-70 vibration exciter was considered best suited to the adaptation of the device: its table-top magnetic field (15 gauss) was lower than the other MB C-25 exciters; and it had an additional 2000 force-pound output capability. Upon installation of the magnetic shield, the table-top stray magnetic field dropped from 15 gauss to 0.70 ± 0.40 gauss. (Measurements were taken using a field current of 11.3 amp and a degaussing current of 1.55 amp.)

[2] With prints and materials available, the shielding system can be built in several days for under $1,000.

III. MAGNETIC SHIELD DESCRIPTION

Figure 3 shows the components of the magnetic-shield device. The shield itself is a round plate, 34½ in. in diameter, constructed of bonded Netic and Conetic layers. The shield rests on a support, which is a ring 5/8 in. thick and which is attached to the exciter cover plate. The fixture plate (which holds the component under test) is attached to the top of the exciter by seventeen standoff studs. The standoff studs are inserted into the moving element of the exciter and protrude through holes drilled in the magnetic shield. The standoff studs allow for the vertical motion of the exciter, which has a double amplitude of 1/2 in. The shield box, covering the component under test, is placed on top of the magnetic shield before the exciter field is turned on. The box has an open bottom and a hinged cover, and is constructed of bonded Netic and Conetic layers.

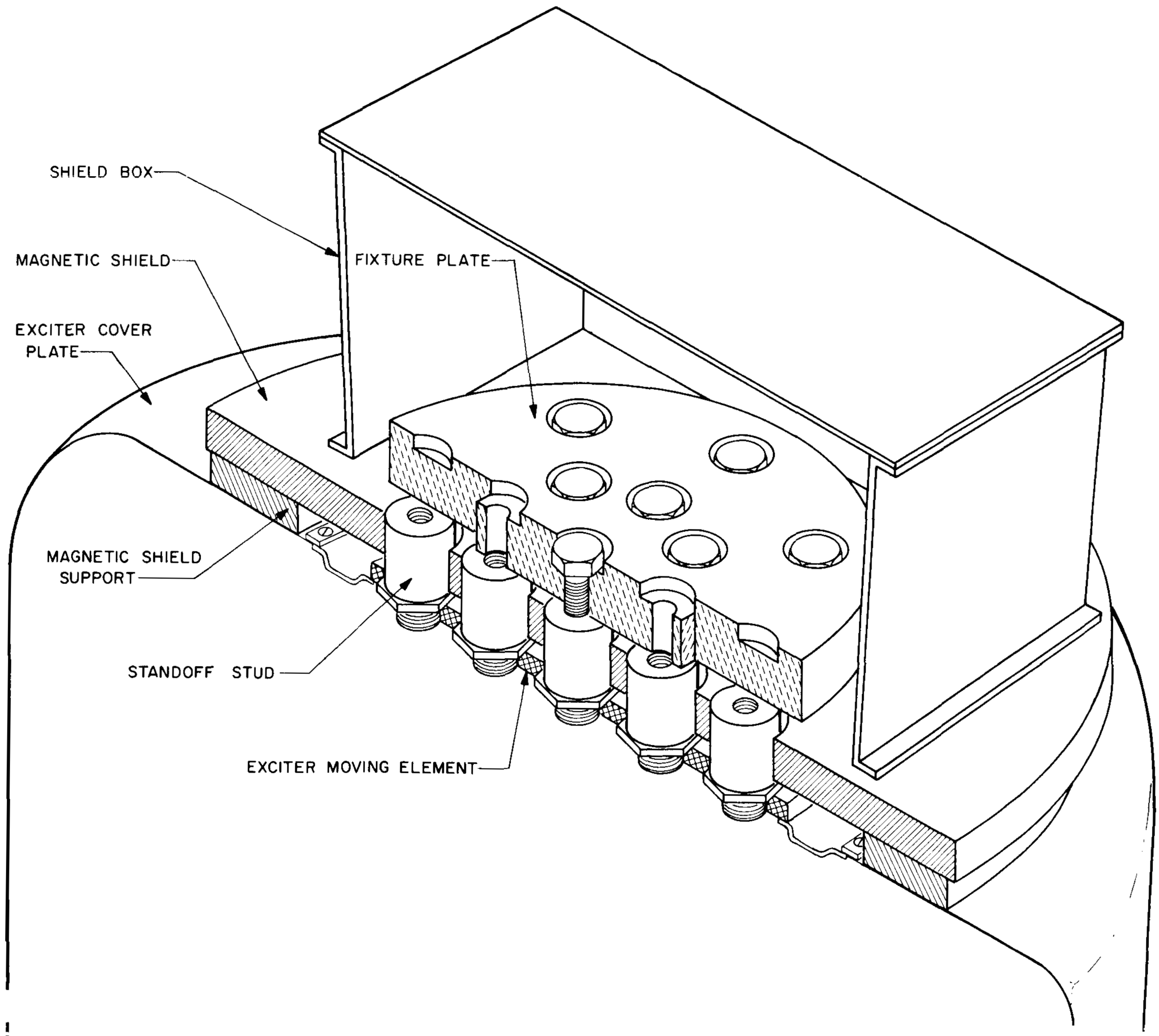

Fig. 3. A cut-away view of the magnetic shield installed on top of a C-70 vibration exciter

ACKNOWLEDGMENTS

The author is grateful to R. C. Woodbury, Jet Propulsion Laboratory, for his help in performing tests with various degaussing currents and for his external "homemade" coil experiments; and to Ron Sneddon, Chief Systems Engineer, Ling-Tempco-Vought, Inc., for technical background information and artwork.